

MINISTRY OF EDUCATION, SINGAPORE  
in collaboration with  
UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE  
General Certificate of Education Ordinary Level

CANDIDATE  
NAME

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CENTRE  
NUMBER

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INDEX  
NUMBER

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Paper 3 Chemistry

October/November 2018

1 hour 15 minutes

Candidates answer on the Question Paper.

No Additional Materials are required.

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**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, index number and name on all the work you hand in.  
You may use an HB pencil for any diagrams, graphs, tables or rough working.

Write in dark blue or black pen.

Do not use staples, paper clips, glue or correction fluid.

The use of an approved scientific calculator is expected, where appropriate.  
You may lose marks if you do not show your working or if you do not use appropriate units.  
**DO NOT WRITE IN ANY BARCODES.**

**Section A**

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

**Section B**

Answer any **two** questions.

Write your answers in the spaces provided on the question paper.

A copy of the Data Sheet is printed on page 15.

A copy of the Periodic Table is printed on page 16.

At the end of the examination, fasten all your work securely together.

The number of marks is given in brackets [ ] at the end of each question or part question.

## Section A

Answer **all** the questions in the spaces provided.

1 When completed, Table 1.1 describes three elements and their oxides. Complete the table.

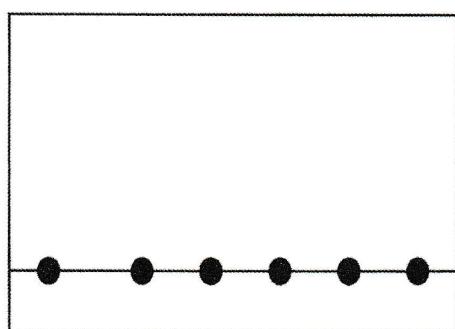
**Table 1.1**

element	metal or non-metal	formula of oxide	nature of oxide (acidic or basic or amphoteric)
sulfur	non-metal	$\text{SO}_2$	acidic
potassium			
aluminium			

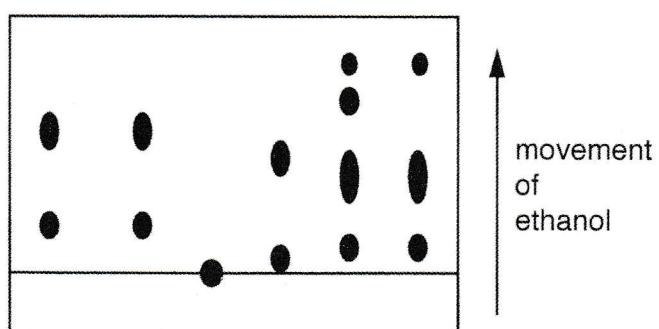
[6]

2 Fig. 2.1 shows a piece of chromatography paper. It has five different food colourings spotted on it labelled **A**, **B**, **C**, **D** and **E**. Spot **Z** is a colouring that contains poisons and so should not be used in foods.

The colourings were separated into their components using chromatography with an ethanol solvent. The resulting chromatogram is shown in Fig. 2.2.



**Fig. 2.1**



**Fig. 2.2**

(a) Using the two figures, state which of the colourings **A**, **B**, **C**, **D** or **E**

(i) is insoluble in ethanol, .....  
(ii) is a mixture of only three food colourings, .....  
(iii) should not be used to colour food. ....

[3]

(b) State which two of **A**, **B**, **C**, **D** and **E** contain the same three food colourings.

..... and ..... [1]

3 The following five boxes describe two solids, two liquids and a gas.

**F**

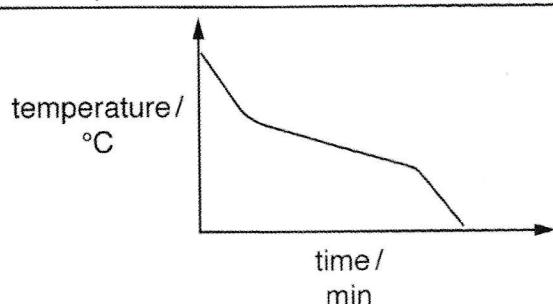
When a magnet is passed over powdered solid **F**, some of the powder is attracted to the magnet.

**G**

Liquid **G** is the only chemical formed when hydrogen burns in oxygen.

**H**

This curve resulted when cooling liquid **H**.



**I**

Solid **I** will **not** conduct electricity when it is a solid but melts at a fixed temperature to become a conductor.

**J**

All the atoms in a molecule of gas **J** are identical.

Classify each of **F**, **G**, **H**, **I** and **J** as an element or a compound or a mixture by placing a tick in the appropriate column in Table 3.1.

Table 3.1

	element	compound	mixture
<b>F</b>			
<b>G</b>			
<b>H</b>			
<b>I</b>			
<b>J</b>			

[5]

4 (a) Name the process by which fuels such as petrol and diesel can be separated from petroleum.

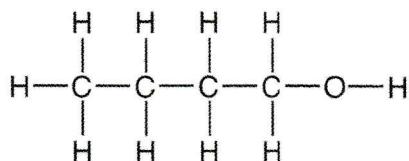
.....[1]

(b) Briefly describe the process in part (a). You may include a sketch with your answer.

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

[4]

5 Simple alcohols form a homologous series. Butanol is an example of an alcohol and has the following structure.



(a) Give the general formula for the homologous series of alcohols.

..... [1]

(b) (i) Name and give the chemical formula for the second member of the homologous series.

name .....

chemical formula .....

[2]

(ii) When left exposed to air, this alcohol is slowly oxidised.

Give the name and draw the full structural formula of the product of this oxidation.

name .....

full structural formula

[3]

6 Table 6.1 contains details of seven different particles. The letters are **not** the chemical symbols.

**Table 6.1**

	<b>K</b>	<b>L</b>	<b>M</b>	<b>N</b>	<b>O</b>	<b>P</b>	<b>Q</b>
nucleon number	3	10	11	14	19	23	35
proton number	2	5	5	7	10	11	17
total number of electrons	2	5	5	7	10	11	18

Use Table 6.1 to state which of particles **K**, **L**, **M**, **N**, **O**, **P** and **Q**

- (a) has a single neutron, .....
- (b) is placed in Group V of the Periodic Table, .....
- (c) has an electronic structure of 2.8, .....
- (d) will form an ionic compound with chlorine, .....
- (e) is an ion with a single negative charge, .....
- (f) are both isotopes of the same element. .... and .....

[6]

7 Fig. 7.1 describes some of the substances that result from the chemical reactions of metal **R**.

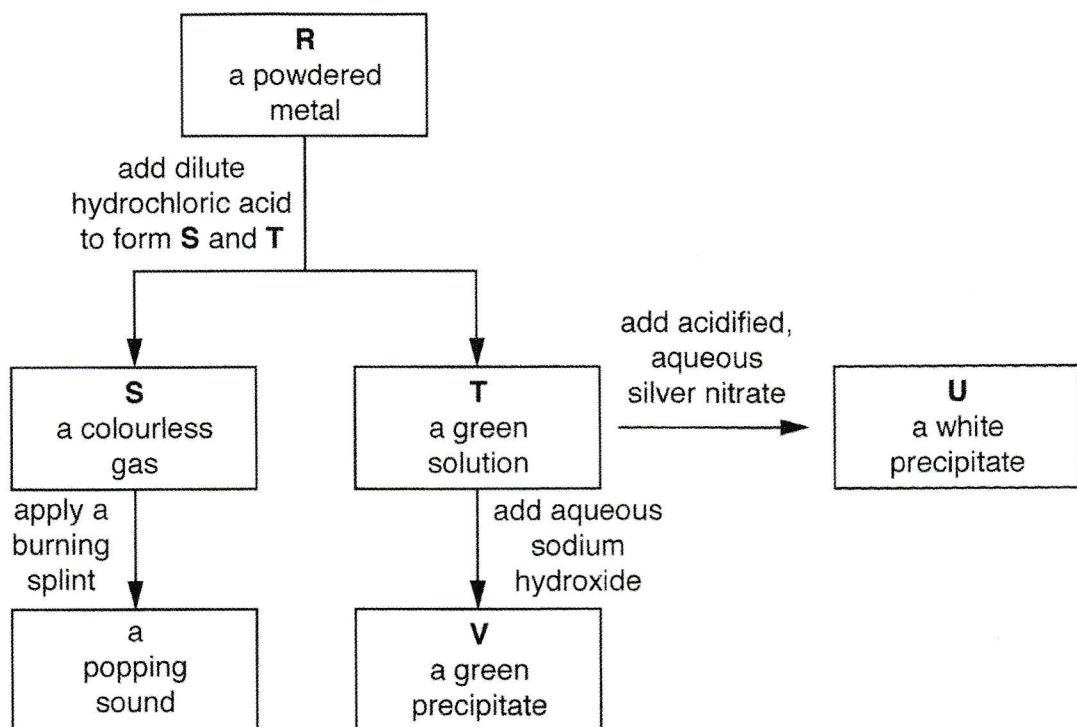


Fig. 7.1

(a) Identify each of **R**, **S**, **T**, **U** and **V**.

**R** .....

**S** .....

**T** .....

**U** .....

**V** .....

[5]

(b) Write a balanced chemical equation for any **one** of the reactions included in Fig. 7.1.

..... [2]

8 Some indigestion tablets reduce stomach acidity. Carbonate ions,  $\text{CO}_3^{2-}$ , in these tablets react with hydrogen ions in the stomach to form water and a gas.

(a) Write the ionic equation for this chemical reaction.

..... [2]

(b) One hundred of these indigestion tablets contain, in total, one mole of carbonate ions.

(i) Calculate how many moles of hydrogen ions are present in  $500\text{ cm}^3$  of a  $0.08\text{ mol/dm}^3$  solution of hydrogen ions.

number of moles of hydrogen ions = ..... [2]

(ii) Calculate how many moles of carbonate ions are needed to neutralise the acidic solution.

number of moles of carbonate ions = ..... [1]

(iii) Calculate how many indigestion tablets are needed to neutralise the acidic solution.

number of tablets = ..... [1]

## Section B

Answer any **two** questions in this section.

Write your answers in the spaces provided.

9 (a) Describe how you would distinguish between an acidic solution and an alkaline solution.

.....  
.....  
.....  
.....  
.....

[2]

(b) The salt magnesium sulfate forms soluble crystals.

Describe how a pure sample of these crystals can be prepared from insoluble magnesium oxide.

.....  
.....  
.....  
.....  
.....  
.....  
.....  
.....

[4]

(c) Ammonia and hydrogen chloride are both compounds. When mixed with water, one of these compounds produces an alkaline solution and the other produces an acidic solution.

(i) Explain why one solution is alkaline and the other is acidic.

.....  
.....  
.....  
.....

[2]

(ii) These two solutions can neutralise one another.

Write either an ionic equation or a chemical equation to represent this neutralisation.

.....

[2]

10 (a) (i) Most chemical reactions occur very quickly and are complete within seconds.

Give an example of such a reaction and write a balanced chemical equation to represent the change.

.....  
.....  
.....  
.....

[3]

(ii) Other chemical reactions take many days to complete. Give an example of a reaction of this type. No chemical equation is required.

.....  
.....

[1]

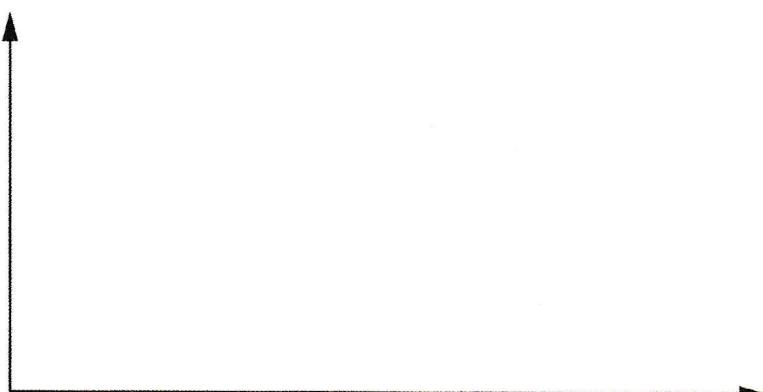
(b) Pieces of calcium react with a dilute acid to produce a gas. This reaction completes in five minutes.

(i) List the measurements you would make to determine the speed of this reaction.

.....  
.....  
.....

[2]

(ii) On the axes below, draw a graph for the measurements made in (b)(i) that would show how the speed of the reaction changes.



[2]

(iii) Describe how you would use your graph in (b)(ii) to determine the speed of the reaction at two minutes.

.....  
.....  
.....  
.....  
.....

[2]

11 (a) Carbon and lithium are in the same period of the Periodic Table but have very different chemical properties.  
[Proton (atomic) numbers: C, 6; Li, 3]

(i) Explain why these two elements are placed in the same period of the Periodic Table.

.....  
.....

[1]

(ii) Explain why these two elements have different chemical properties.

.....  
.....

[1]

(b) Carbon dioxide is a gas at room temperature and pressure.

(i) Draw a 'dot and cross' diagram to show the arrangement of the outer shell electrons in one molecule of carbon dioxide.  
[Proton numbers: C, 6; O, 8]

[2]

(ii) Carbon dioxide can be liquefied and has a low boiling point.

Explain, with reference to the structure of carbon dioxide, why the boiling point is low.

.....  
.....  
.....  
.....  
.....

[2]

(c) When carbon dioxide is bubbled through limewater (aqueous calcium hydroxide), a white precipitate is formed.

Write a balanced chemical equation for this reaction and use your equation to calculate the maximum mass of precipitate that can form when 4.0g of the gas is bubbled through limewater.

[Relative atomic masses: A<sub>r</sub>: H, 1; C, 12; O, 16; Ca, 40]

chemical equation

.....

mass of precipitate = ..... g

[4]

33. (D)

Since magnesium is more reactive than zinc, it will displace zinc from its salt to form magnesium sulfate and zinc metal.

**EXAM TIP:**

The more reactive element displaces the less reactive element in a reaction.

34. (A)

Recycling reduces the need for mining for raw materials and conserves the amount of natural resources available.

**EXAM TIP:**

Recall the advantages of recycling metals.

35. (C)

**EXAM TIP:**

Dry air consists of approximately 78% nitrogen, 21% oxygen, 0.97% noble gases (mainly argon) and 0.03% carbon dioxide.

36. (D)

Acid rain results when nitrogen oxides and sulfur dioxide dissolve in rain water. Acid rain causes the erosion of buildings when it reacts with structures with metal or carbonates.

**EXAM TIP:**

Nitrogen dioxide and sulfur dioxide cause the erosion of buildings.

37. (D)

Alkanes are saturated hydrocarbons, do not contain a double bond and will not decolourise aqueous bromine water, unlike alkenes.

**EXAM TIP:**

Both alkanes and alkenes undergo complete combustion, producing carbon dioxide and water.

38. (D)

Both  $\text{CH}_4$  and  $\text{C}_6\text{H}_{14}$  have the same general formula of  $\text{C}_n\text{H}_{2n+2}$ .

**EXAM TIP:**

The general formula of alkanes is  $\text{C}_n\text{H}_{2n+2}$  and the general formula of alkenes is  $\text{C}_n\text{H}_{2n}$ .

39. (C)

The monomer used is an alkene, which is unsaturated. Alkenes react with aqueous bromine via addition reaction, changing its colour from reddish brown to colourless.

**EXAM TIP:**

Addition polymerisation occurs for unsaturated monomers. When aqueous bromine is added to an unsaturated compound, the colour of aqueous bromine will turn from reddish-brown to colourless.

40. (B)

(A): Ethanol undergoes oxidation to form ethanoic acid.

(C): Ethene undergoes addition polymerisation to form poly(ethene).

(D): Glucose undergoes fermentation to form ethanol and carbon dioxide.

No single chemical reaction can directly convert ethanol to propanol.

**EXAM TIP:**

Recall the reactions of organic compounds.

October/November 2018

Paper 3

Section A

1.

element	metal or non-metal	formula of oxide	nature of oxide (acidic or basic or amphoteric)
sulfur	non-metal	$\text{SO}_2$	acidic
potassium	metal	$\text{K}_2\text{O}$	basic
aluminium	metal	$\text{Al}_2\text{O}_3$	amphoteric

**EXAM TIP:**

Non-metals usually form acidic oxides; metals usually form basic oxides; amphoteric oxides display both acidic and basic properties.

2. (a) (i) B

**EXAM TIP:**

The colouring with spot that remains at the start line of the chromatography paper is insoluble in ethanol.

(ii) E

**EXAM TIP:**

Three spots on the chromatography paper indicate that the colouring is a mixture of only three food colourings.

(iii) A

**EXAM TIP:**

The colouring with two spots at the exact same positions as the two spots of Z contains poisons and so should not be used in foods.

(b) D and E

**EXAM TIP:**

Look for two food colourings that have three spots at the exact same positions.

3.

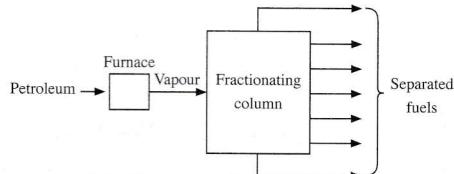
element	compound	mixture
F		✓
G	✓	
H		✓
I	✓	
J	✓	

**EXAM TIP:**

An element is a substance that cannot be broken down into simpler substances through any chemical or physical means. A compound is a substance that contains two or more elements which are chemically combined in a fixed ratio. A mixture consists of two or more substances that are mixed together.

4. (a) Fractional distillation

(b)



Petroleum is first heated into the gaseous state in a furnace. The vapour enters a fractionating column, where the different hydrocarbons condense at different temperatures. Thus, the different fuels, such as petrol and diesel, are separated into different fractions based on their different boiling points.

Fuels with lower boiling points, such as petrol, will be collected first, at the top of the fractionating column; while fuels with higher boiling points, such as diesel, will be collected later, at the bottom of the fractionating column.

**EXAM TIP:**

In cases where a mixture contains liquids that have relatively close boiling points, fractional distillation is used for purification.

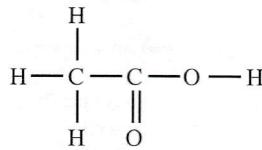
5. (a)  $C_nH_{2n+1}OH$ 

(b) (i) name: Ethanol

chemical formula:  $C_2H_5OH$ 

(ii) name: Ethanoic acid

full structural formula:

**EXAM TIP:**

Alcohols are oxidised to form carboxylic acids.

6. (a) K

**EXAM TIP:**

Number of neutrons = number of nucleons – number of protons

(b) N

**EXAM TIP:**

The particle with 5 valence electrons is placed in Group V of the Periodic Table.

(c) O

**EXAM TIP:**

The total number of electrons can be determined from the electronic structure of the particle.

(d) P

**EXAM TIP:**

A metal will form an ionic compound with a non-metal (in this case, chlorine is the non-metal).

(e) Q

**EXAM TIP:**

An ion with a single negative charge indicates that the particle has gained 1 electron to attain a noble gas electronic configuration.

(f) L and M

**EXAM TIP:**

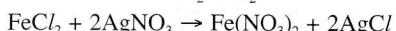
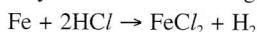
Isotopes are atoms of the same element that have the same number of protons but different numbers of neutrons.

7. (a) R Iron, Fe

S Hydrogen,  $H_2$ T Iron(II) chloride,  $FeCl_2$ U Silver chloride,  $AgCl$ V Iron(II) hydroxide,  $Fe(OH)_2$ **EXAM TIP:**

In a reaction between a metal and dilute hydrochloric acid, hydrogen gas and an aqueous solution are formed. The result from the addition of acidified aqueous silver nitrate to solution T helps to identify the anion present in T. The result from the addition of aqueous sodium hydroxide to solution T helps to identify the cation present in T.

(b) Any one of the following:

8. (a)  $CO_3^{2-} + 2H^+ \rightarrow H_2O + CO_2$ 

(b) (i) Number of moles of hydrogen ions

$$\begin{aligned}
 &= \frac{500}{1000} \times 0.08 \\
 &= 0.04 \text{ mol}
 \end{aligned}$$

**EXAM TIP:**

Number of moles = Concentration  $\times$  Volume

(ii) Since 2 mol of  $H^+$  reacts with 1 mol of  $CO_3^{2-}$ ,

number of moles of carbonate ions needed

$$= 0.04 \div 2$$

$$= 0.02 \text{ mol}$$

(iii) Number of moles of carbonate ions in each tablet

$$= 1 \div 100$$

$$= 0.01 \text{ mol}$$

$$\text{Number of tablets needed} = 0.02 \div 0.01$$

$$= 2$$

**EXAM TIP:**

Find the number of mole of carbonate ions contained in one tablet and then calculate how many tablets contain the number of moles of carbonate ions needed to neutralise the acidic solution.

## Section B

9. (a) Dip red and blue litmus papers in the solution. If the solution is acidic, the blue litmus paper turns red.

If the solution is alkaline, the red litmus paper turns blue.

(Other acceptable answer:

Add a few drops of Universal Indicator in the solution. The solution will turn red/yellow if it is acidic, and turn violet/blue if it is alkaline.)

**EXAM TIP:**

Acids turn blue litmus paper red. Alkalies turn red litmus paper blue.

(b) Add excess magnesium oxide into a solution of sulfuric acid. Filter to remove excess magnesium oxide as residue. Heat the filtrate of magnesium sulfate until saturation. Allow the saturated solution to cool and crystallise. Wash the crystals with distilled water and dry the crystals with filter paper.

**EXAM TIP:**

Filtration is used to separate a mixture of a liquid (or solution) and an insoluble solid.

(c) (i) Ammonia dissolves in water to produce  $\text{OH}^-$  ions, producing an alkaline solution. Hydrogen chloride dissolves in water to produce  $\text{H}^+$  ions, producing an acidic solution.

**EXAM TIP:**

An acid is a substance that dissolves in water to produce hydrogen ions ( $\text{H}^+$ ), while an alkali is a substance that dissolves in water to produce  $\text{OH}^-$  ions.

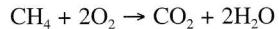


10. (a) (i) Reaction of sodium metal with water:



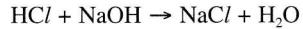
or

Combustion of methane:



or

Neutralisation reaction between hydrochloric acid and sodium hydroxide:



(ii) Fermentation / Rusting

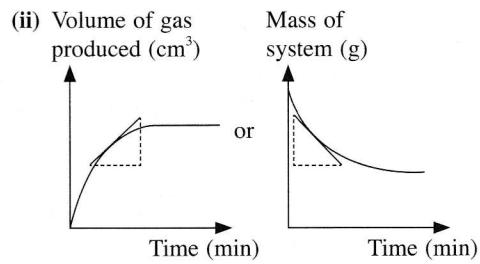
(b) (i) Measure the volume of gas produced using a gas syringe at fixed time intervals (e.g. 1 minute).

(Other acceptable answer:

Measure the mass of the reactants at fixed time intervals (e.g. 1 minute.).

**EXAM TIP:**

The speed of this reaction is the volume of gas produced per minute or the mass of system per minute.



(iii) Draw a tangent to the graph at time = 2 minutes and calculate the gradient of the tangent.

The rate of the reaction at time = 2 minutes will be equal to the gradient calculated.

**EXAM TIP:**

The speed of the reaction can be determined from the gradient of the tangent of the graph.

11. (a) (i) Both elements have the same total number of electron shells.

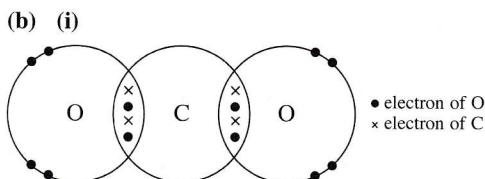
**EXAM TIP:**

Elements placed in the same period of the Periodic Table have the same total number of electron shells.

(ii) Both elements have a different numbers of valence electrons.

**EXAM TIP:**

Elements placed in different groups of the Periodic Table have different chemical properties.



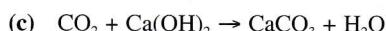
**EXAM TIP:**

Carbon atoms and oxygen atoms are bonded by covalent bonds to form carbon dioxide.

(ii) Carbon dioxide is a simple covalent molecule. Small amount of energy is required to overcome the weak intermolecular forces of attraction between the molecules, and thus, carbon dioxide has a low boiling point.

**EXAM TIP:**

Simple covalent molecules have low boiling points.



Number of moles of  $\text{CO}_2$  gas

$$= \frac{4.0}{12 + 16 + 16}$$

$$= 0.090910 \text{ mol (to 5 s.f.)}$$

Since 1 mol of  $\text{CO}_2$  reacts with 1 mol of  $\text{CaCO}_3$ ,

number of moles of  $\text{CaCO}_3$  precipitate

$$= 0.090910 \text{ mol}$$

Maximum mass of  $\text{CaCO}_3$  precipitate

$$= 0.090910[40 + 12 + 16(3)]$$

$$= 9.091 \text{ g}$$

$$= 9.09 \text{ g (to 3 s.f.)}$$

**EXAM TIP:**

$$\text{Number of moles of substance} = \frac{\text{Mass}}{\text{Molar mass}};$$

$$\text{Mass} = \text{Number of moles} \times \text{Molar mass}$$

October/November 2017

Paper 1

Multiple Choice Questions

21. (C)

Since bromine is at its liquid state at  $20^\circ\text{C}$ , its melting point must be lower than  $20^\circ\text{C}$ , while the boiling point must be higher than  $20^\circ\text{C}$ .

**EXAM TIP:**

At the melting point, a substance undergoes a change from solid state to liquid state. At the boiling point, a substance undergoes a change from liquid state to gaseous state.

22. (D)

When  $\text{NaOH}(\text{aq})$  is added, a white precipitate is formed, which is soluble in excess  $\text{NaOH}(\text{aq})$ .

→ The cation present is either  $\text{Zn}^{2+}$  or  $\text{Pb}^{2+}$ .

When  $\text{NH}_3(\text{aq})$  is added, a white precipitate is formed, which is soluble in excess  $\text{NH}_3(\text{aq})$ .

→ The cation present is  $\text{Zn}^{2+}$ .

When aluminium and aqueous hydroxide is warmed with the solution, alkaline  $\text{NH}_3$  is formed.

→ The anion present is  $\text{NO}_3^-$ .

∴ Compound Z is zinc nitrate.

**EXAM TIP:**

Recall the test for cations and anions.

23. (A)

The proton number of  ${}^{40}_{19}\text{K}$  is 19, therefore the number of protons in the atom is 19. Since an atom contains an equal number of protons and electrons, the number of electrons in the atom is 19. The nucleon number is 40, therefore there are  $40 - 19 = 21$  neutrons.

**EXAM TIP:**

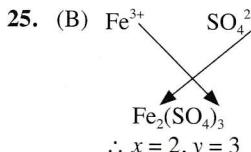
The proton number is shown on the bottom left of the chemical symbol while the nucleon number is on the top left. Number of neutrons = number of nucleons – number of protons.

24. (C)

An ionic compound consists of positively- and negatively-charged ions arranged in a giant lattice structure, has a high melting point, and conducts electricity only in molten or aqueous state but not in solid state.

**EXAM TIP:**

Sodium chloride consists of  $\text{Na}^+$  and  $\text{Cl}^-$  ions.



**EXAM TIP:**

Iron(III) sulfate consists of 2  $\text{Fe}^{3+}$  ions and 3  $\text{SO}_4^{2-}$  ions.

26. (A)

$$\text{Number of moles of glucose} = 0.4 \times \frac{50}{1000} = 0.02 \text{ mol}$$

$$\text{Mass of glucose} = 0.02 \times 180$$

$$= 3.6 \text{ g}$$

∴ 3.6 grams of glucose are added to 50  $\text{cm}^3$  of water to make a solution of concentration 0.4 mol /  $\text{dm}^3$ .

**EXAM TIP:**

Number of moles = Concentration  $\times$  Volume;

Mass = Number of moles  $\times$  Molar mass